Open source technology in biomedical engineering: fast track towards sustainable development

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I. INTRODUCTION

The scarcity of accessible quality healthcare in Africa is inextricably linked not only with the lack of resources, but also with the lack of adequately trained biomedical engineers. Capacity building in this sector is a key for advancement and more important for the establishment of a sustainable health-care system. Excluding South Africa, apart from few singular initiatives (in Nigeria and Ghana), no university in sub-Saharan Africa offers a fully-fledged Biomedical Engineering graduate and post-graduate programme [1]. Africa has one of the youngest demographics, so targeting young students is the key to driving healthcare improvements through rapidly and efficiently. One way of reaching this goal is to use the immediacy and high information content offered by the internet combined with the open source approach to teach design and fabrication of biomedical devices at university level. Open source means to share the design, documentation, source-code, ideas and bug fixes as well as results and collected data with others. In the context of BME, we still need a high level of supervision, to control the quality and to guarantee the respect of safety standards [2]. Therefore, the core curriculum for biomedical engineering must also include courses on biomedical device regulations and standards. This approach needs not only be used in developing countries; even in Europe new methods are required to face new health-care challenges represented by shifting demographics, changing lifestyles and a continuous flow of immigrants.

II. CONCEPT AND APPROACH

To address these challenges, the EU funded UBORA project aims at creating an e-Infrastructure, UBORA, for open source co-design of new solutions to face the current and future healthcare challenges of Europe and Africa. UB-ORA (”excellence” in Swahili) brings together European and African Universities and their associated technological hubs (supporting biomedical prototyping laboratories and incubators) to construct a new method for designing biomedical de-vices. The e-Infrastructure will take engineers and engineering students through a process of needs identification, solid modelling, device classification and regulation and production in which each stage is vetted and monitored by experts to ensure that safety criteria are met during the design process. Throughout we will be exploiting and reinforcing networking, knowledge on rapid prototyping of new ideas and sharing of performance and quality data in order to maximise innovation and minimise waste. UBORA is supported by national and international policymakers and committed and credible stakeholders and propelled by a series of summer schools and design competitions. The design competitions are inspired by the UNECA (United

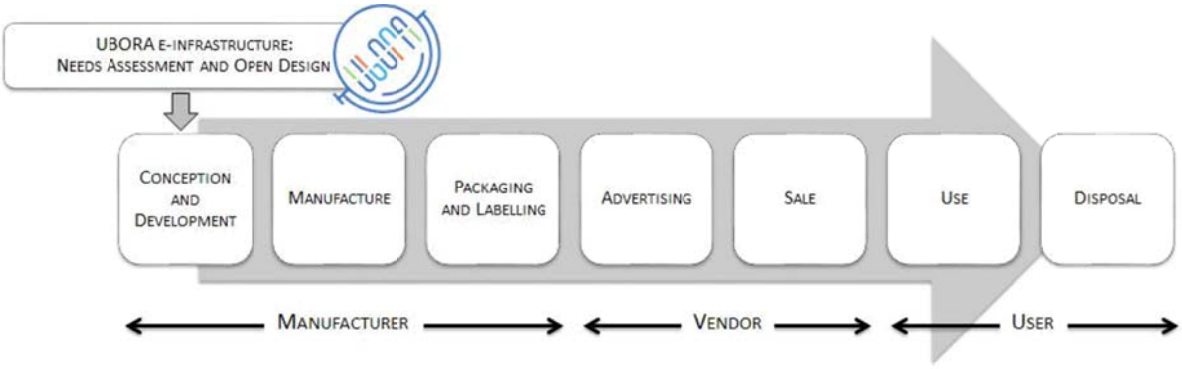

Fig. 1: The lifecycle of biomedical device

Nations Economic Commission for Africa) funded Innovator Summer Schools (ISS). Since 2013 the themes of the ISS have focused on the co-development of biomedical devices based on local needs and materials. Ta-ble 1 lists the Summer Schools held so far on different topics related to Biomedical Engineering.

Table 1: ISS held since 2013. All ISS were funded by UNECA

Innovator Summer School	Hosting Institution	Period	Topic
2013	Kenyatta University - Nairobi, Kenya	August 12th - 16th	Introduction to Biomedical Device Regulations and Rapid Prototyping
2014	Muhimbili University of Health and Allied Science - Dar Es Salaam, Tanzania	December 8th - 12th	From Making to Marketing
2016	Addis Ababa Institute of Technology - Addis Ababa, Ethiopia	January 11th - 15th	Application of mobile phones in healthcare product design and development
2017	Cairo University - Cairo, Egypt	January 23rd -27th	Biomedical and Clinical Data and Informatics for Development in Africa

Thanks to UNECA the ISS brings together a community of African universities committed to developing a joint curriculum in biomedical engineering and to bringing excellence to this field from an academic point of view. Underlying this ambition is the awareness that quality healthcare is the key to well-being and wealth. With UNECA's support, 13 universities in Africa have joined to form a consortium known as ABEC (African Biomedical Engineering Consortium). UBORA was born out of these initiatives, and seeks to extend the ISS through the creation of an OSMD co-creation platform.

III. UBORA IMPLEMENTATION

The e-Infrastructure is being implemented to foster advances in education and the development of innovative solutions in Biomedical Engineering, both of which are flywheels for emerging and developed economies.

As shown in Figure 1, the lifecycle of a medical device has numerous phases, which go from needs assessment to man-ufacture, sales and disposal. UBORA will focus on the first phase, which is the most important for vehicling the gener-ation of new solutions. Conception and development will be channelled following European biomedical device directives such that each step of the process takes account of apposite European regulations.

As the Infrastructure develops it will be populated by and tested through designs emerging from young biomedical engineers during the design competitions. A small logo design competition was launched in November 2016 to kick start the project, disseminate the main idea of sharing amongst stu-dents and come up with an emblematic symbol for the project [Figure 2]. The logo communicates many different compo-nents, including the notion of innovation and sharing between Africa and the rest of the world. In order to convey a message combining these components, and to balance formality with informality, the concept of a virtual infrastructure is repre-sented by using a world globe with a stand as a starting point.

An announcement for a new design competition has already been placed on the web and is being disseminated through social media. According to WHO, the first 28 days of life represent the most vulnerable time for a childs sur-vival, and in 2015, 5.9 million child deaths under the age of 5 were reported. Therefore the UBORA design challenge focuses on creating effective and affordable solutions which will contribute to improved child health outcomes. In partic-ular, the 2017 UBORA Design Competition seeks innovative biomedical engineering solutions from students (individuals or teams) to reduce child mortality. For the 24 best-ranked projects travel and full-board will be provided for one team member to attend the UBORA Design School to be held in Kenyatta University (Nairobi Kenya) from 23rd to 27th October 2017.

Fig. 2: UBORA's logo was designed by Pehr Wessmark, from the Royal Institute of Technology, Sweden

IV. Conclusion

What are the pros and cons of this open approach? Certainly, the method of sharing designs and allowing design modifications and a creative commons type of licensing could be thought of as detrimental to the concept of intellectual property and ownership. Moreover, it is possible that com-mercial investors shy away from open technology because it is considered less rewarding. Contrary to this position, sev-eral leading economists recommend shifts in the process of technology acquisition from closed, locked-in black box sys-tems to open and modular approaches [3] [4].

These shifts, in turn, enable a business process migration from proprietary products that can only be changed by one vendor, towards a flexible marketplace for professional services to extend and adapt capabilities on demand and in a contextual manner. Put in a biomedical perspective, OSMDs are based on open standards, needs based systems, open source collaboration and reference open source performance data and implementations. By crossing through the use of web-based networks there will also be a natural move towards harmonization of technology and quality, which is severely lacking in Africa [5].

The UBORA e-Infrastructure is the tool for biomedical engineers to drive this forward, for a better world, where bet-ter health is not just for the privileged few. Through UB-ORA, the biomedical community can generate and share data and blueprints of biomedical devices, accompanied by the required procedures for respecting quality assurance, and assessing performance and safety. When properly implemented, and guaranteed by authorized Notified Bodies, these biomedical devices can safely be used in hospitals and on pa-tients throughout the world.

Conflict of Interest

The authors declare that they have no conflict of interest.

Acknowledgements

This project has received funding from the European Unions Horizon 2020 research and innovation programme under grant agreement No 731053. The authors thank UN-ECA for their continued support and Pehr Wessmark for de-signing the logo.

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